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# LIST OF TABLES

# LIST OF ACRONYMS

| | |
|---|---|
| 2,3,7,8-TCDD | Tetrachlorodibenzo-p-dioxin |
| AOPC | Area of Potential Concern |
| BAP | Benzo(a)pyrene |
| BaPEq | Benzo(a)pyrene Equivalent |
| BERA | Baseline Ecological Risk Assessment |
| BHHRA | Baseline Human Health Risk Assessment |
| BTEX | Benzene, Toluene, Ethylbenzene, and Xylene |
| CASRN | Chemical Abstracts Service Registry Number |
| cm | centimeter |
| cPAH | carcinogenic Polycyclic Aromatic Hydrocarbon |
| DDD | Dichloro-diphenyl-dichloroethane |
| DDE | Dichloro-diphenyl-dichloroethene |
| DDT | Dichloro-diphenyl-trichloroethane |
| EPA | U.S. Environmental Protection Agency |
| FS | Feasibility Study |
| HPAH | High-molecular-weight Polycyclic Aromatic Hydrocarbon |
| LPAH | Low-molecular-weight Polycyclic Aromatic Hydrocarbon |
| LWG | Lower Willamette Group |
| NAVD88 | North American Vertical Datum of 1988 |
| OC | Organic Carbon |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PCB | Polychlorinated Biphenyl |
| PCDD/F | Dibenzo-p-dioxin/furan |
| PEFs | Potency Equivalent Factors |
| PRGs | Preliminary Remediation Goals |
| RI | Remedial Investigation |
| RM | River Mile |
| SCRA | Site Characterization and Risk Assessment |
| SMA | Sediment Management Area |
| TEF | Toxic Equivalency Factors |
| TEQ | Toxic Equivalent |
| TOC | Total Organic Carbon |
| TZW | Transition Zone Water |
| VOC | Volatile Organic Compound |
| WHO | World Health Organization |

## ~~EXECUTIVE SUMMARY~~

~~This appendix describes the preparation and contents of the draft Feasibility Study (FS) sediment database provided to EPA in March of 2011. Data selection criteria for the draft FS sediment database follow Portland Harbor draft final Remedial Investigation (RI) dataset rules (Integral et al. 2011). However, summation rules are calculated according to the Baseline Ecological Risk Assessment (BERA) and Baseline Human Health Risk Assessment (BHHRA) summing rules (also documented in the draft final RI). The sediment database provides a consistent dataset for evaluations supporting the draft FS, including the estimation of areas and volumes of sediments to be remediated.~~

## ~~4.0~~1.0 INTRODUCTION

This appendix describes the preparation and contents of the draft Feasibility Study (FS) sediment and 2014 FS database. ~~provided to EPA in March of 2011. The sediment database provides a consistent dataset for evaluations supporting the draft FS, including the estimation of areas and volumes of sediments to be remediated.~~ This database does not include porewater data. Surface water and transition zone water (TZW) databases will be produced and delivered separately. An additional subset of data was selected for the *Stormwater Loading Methods Report* (Anchor QEA 2011) from a subset of the site characterization and risk assessment (SCRA) stormwater data. This database was defined as the draft FS Stormwater Database, which was submitted to the U.S. Environmental Protection Agency (EPA) with the *Stormwater Loading Methods Repor*t. All other datasets were identical to those used in the Remedial Investigation (RI).

The source of the data is the SCRA database as transmitted to Anchor QEA from Integral Consulting, Inc (Integral) on August 10, 2009, additional updates to the SCRA database posted to the Lower Willamette Group (LWG) portal through February 4, 2011, including change log updates through February 3, 2011 13:11. Any updates to the SCRA after February 4, 2011, have not been incorporated into the draft FS sediment database. The 2014 FS database is identical to the draft FS sediment database with the exception of surface and subsurface sediment data collected at the Gasco/Siltronic and Arkema early action sites through April 2011 added by EPA. The draft FS database was developed consistent with the process described in the following sections. EPA added data to the 2014 database consistent with these approaches.

Data handling rules for the SCRA database are described in *Guidelines for Data Averaging and Treatment of Non-detected Values for Round 1 Database* (Kennedy/Jenks et al. 2004).

Data selection criteria for the ~~draft~~ 2014 FS sediment database follow Portland Harbor draft final RI dataset rules (Integral et al. 2011). However, summation rules are calculated according to the Baseline Ecological Risk Assessment (BERA) and Baseline

Human Health Risk Assessment (BHHRA) summing rules (also documented in the draft final RI), further detailed as follows.

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## ~~5.0~~2.0 DATA SELECTION

As discussed in detail in the RI, environmental data have been collected within the Portland Harbor Site during numerous LWG sampling events and from other historical and concurrent studies and constitute the Portland Harbor SCRA database. The data lockdown date for the RI database was July 19, 2010. ~~The Portland Harbor SCRA database was transmitted to members of the LWG RI and risk assessment teams on June 2, 2008. These data were used in the draft and revised draft final RI and risk assessments. The RI, BERA, and BHHRA database managers separately queried the SCRA database to derive subsets of data to support their respective efforts, as described in the draft final RI.~~

Additional sediment data were obtained subsequent to the June 2008 RI transmittal and were incorporated into an updated SCRA database. ~~, which is presented in Appendix H of the draft final RI report.~~ This update includes all available data obtained by February 4, 2011, and is the dataset used in the draft FS. Additional selections and data reduction steps were applied to the updated SCRA datasets to fulfill specific data evaluation and presentation needs of the draft FS, and this subset of data is referred to as the draft FS database.

Other than the update of data as of February 4, 2011, the draft FS dataset is identical to the RI dataset. The 2014 FS sediment database is identical to the draft FS sediment database with the exception of surface and subsurface sediment data collected at the Gasco/~~ and~~ Siltronic and Arkema early action sites through April 2011.

~~Data used for the Comprehensive Benthic Risk Approach (draft FS Appendix P) to delineate benthic areas of concern are detailed in Table 4-2 of the BERA (Windward 2011). The fate and transport model only includes data added to the SCRA database as of September 10, 2009, and does not include additional data added on February 4, 2011.~~

The 2014~~draft~~ FS sediment database was derived from the SCRA database prepared by Integral and provided to Anchor QEA up to February 4, 2011, and was compiled using the following guidelines:

- Includes data collected on or after May 1, 1997. Includes only samples with a sediment matrix (sample matrix code "SE"); this does not include sediment trap data.
- Includes only data from locations with an elevation of less than or equal to 13 feet North American Vertical Datum of 1988 (NAVD88).
- Excludes sample results from locations that have been subject to early action, marked as "dredged" or "capped."
- Per RI data selection rules, includes data that had a quality assurance approval code indicating a Category 1-level of data quality and either a level of validation of "QA1" or "QA2" (see Section 2.1 of Integral et al. 2011).

- Includes sample results from locations with river mile (RM) designations ranging from 0 to 26.1, as well as from Multnomah Channel locations (RM "-99"). The draft FS Site extends from RM 1.9 through RM 11.8.

EPA then added Gasco/Siltronic and Arkema early action sediment data to above compiled data.~~.~~

- :"

## ~~5.1~~2.1 DEPTH CATEGORIZATION

Depths for sediment data have been categorized as follows: surface sediments are defined as samples with a start depth of 0 and end depth of less than or equal to 40 centimeters (cm). All other samples are considered to be subsurface sediments.

## ~~5.2~~2.2 SPATIAL CATEGORIZATION

This version of the database does not contain information regarding the area of potential concern (AOPC) or sediment management area (SMA) associated with a given location. The user must generate these relationships through GIS-based spatial analysis.

## ~~5.3~~2.3 ANALYTE NOMENCLATURE

Analytes are distinguished by their Chemical Abstracts Service registry number (CASRN) or by their analyte name. Where an analyte may have two or more synonyms, the LWG Nature and Extent nomenclature has been retained. In the case of calculated analyte group totals where a CASRN is not available, a project-specific CASRN has been assigned.

As will be further defined in the following sections, analyte group totals were calculated for the analyte groups used for the preliminary remediation goals (PRGs), which are the basis for remedial design. In addition, some parameters were normalized by organic carbon (OC), as further defined in Section 3.

## ~~6.0~~3.0 NORMALIZATION BY ORGANIC CARBON

When calculating OC-normalized results, a value of 0.2 percent was used whenever the reported total organic carbon (TOC) result was less than 0.2 percent or if the TOC result was non-detect. If a sediment sample did not have a reported TOC result, a value of 1 percent was assumed. The final result was rounded to the minimum number of significant figures among the source analyte results. In the case of an assumed TOC value, two significant figures were assumed.

# ~~7.0~~4.0 CALCULATION OF ANALYTE TOTALS

## ~~7.1~~4.1 INTRODUCTION

Calculation of analyte group totals follows the baseline risk assessment rules defined in the draft final RI (Integral et al. 2011). The procedures are summarized as follows:

- Calculated totals are the sum of all detected results and non-detected results at one half the reporting detection limit for analytes detected at least once in the risk assessment dataset within the Site for a given medium.
- If none of the analytes are detected for a given sample, but are determined to be present within the Site, then the highest detection limit is used for the summation.
- Analytes never detected within a dataset for a given medium are excluded from totals.

The following analyte totals are provided in the database, under the Chemical_Name and CAS_RN columns as shown in Table 1.

**Table 1. Analyte Nomenclature for Analyte Totals Contained in the Feasibility Study Sediment Database**

| Analyte Group | Description | Chemical_Name | CAS_RN |
|---|---|---|---|
| Pesticides | Total 2,4-DDx | LWG RA Sum 2,4 DDT, DDE, DDD (Calculated U = 1/2) | LRASum_DDT2_N |
| Pesticides | Total 4,4-DDx | LWG RA Sum 4,4 DDT, DDE, DDD (Calculated U = 1/2) | LRASum_DDT4_N |
| Pesticides | Total DDD | LWG RA Sum DDD (Calculated U = 1/2) | LRASum_DDD_N |
| Pesticides | Total DDE | LWG RA Sum DDE (Calculated U = 1/2) | LRASum_DDE_N |
| Pesticides | Total DDT | LWG RA Sum DDT (Calculated U = 1/2) | LRASum_DDT_N |
| Pesticides | Total DDx | LWG RA Total DDx (Calculated U = 1/2) | LRAtDDT_N |
| Pesticides | Total Chlordane | LWG RA Total Chlordane (Calculated U = 1/2) | LRAtChlordan_N |
| Pesticides | Total Endosulfan | LWG RA Total Endosulfan (Calculated U = 1/2) | LRAtENDOSLF_N |
| PAHs | Total LPAH | LWG RA Total 7 of 17 LPAH (Calculated U = 1/2) | LRAtPAH_17_LM_N |
| PAHs | Total HPAH | LWG RA Total 10 of 17 HPAH (Calculated U = 1/2) | LRAtPAH_17_HM_N |
| PAHs | Total PAH | LWG RA Total 17 PAH (Calculated U = 1/2) | LRAtPAH_17_N |
| PAHs | Total cPAH (BaPeq) | LWG RA Total cPAH TEQ (EPA 1993) (Calculated U = 1/2) | LRAtcPAHTEF7_N |
| VOCs | Total Benzo(x)fluoranthenes | LWG RA Total Benzo(x)fluoranthenes (Calculated U = 1/2) | LRAtBF_N |

| Analyte Group | Description | Chemical_Name | CAS_RN |
|---|---|---|---|
| VOCs | BTEX | LWG RA Total BTEX (Calculated U = 1/2) | LRAtBTEX_N |
| VOCs | Total Xylene | LWG RA Total Xylene (Calculated U = 1/2) | LRAtXylene_N |
| PCB_Homologs | Mono-CB | LWG RA Total Monochlorobiphenyl homologs (Calculated U = 1/2) | LRASum_MonPCB_N |
| PCB_Homologs | Dichloro-CB | LWG RA Total Dichlorobiphenyl homologs (Calculated U = 1/2) | LRASum_DiPCB_N |
| PCB_Homologs | Tri-CB | LWG RA Total Trichlorobiphenyl homologs (Calculated U = 1/2) | LRASum_TriPCB_N |
| PCB_Homologs | Tetra-CB | LWG RA Total Tetrachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_TetPCB_N |
| PCB_Homologs | Penta-CB | LWG RA Total Pentachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_PenPCB_N |
| PCB_Homologs | Hexa-CB | LWG RA Total Hexachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_HexPCB_N |
| PCB_Homologs | Hepta-CB | LWG RA Total Heptachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_HepPCB_N |
| PCB_Homologs | Octa-CB | LWG RA Total Octachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_OctPCB_N |
| PCB_Homologs | Nona-CB | LWG RA Total Nonachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_DecPCB_N |
| PCB_Homologs | Deca-CB | LWG RA Total Decachlorobiphenyl homologs (Calculated U = 1/2) | LRASum_NonPCB_N |
| Total PCBs | Total PCB Aroclors | LWG RA Total PCB Aroclors (Calculated U = 1/2) | LRAtPCB_N |
| Total PCBs | Total PCB Congeners | LWG RA Total PCB Congener (Calculated U = 1/2) | LRAtPCBCong_N |
| Dioxins_Furans | Total Dioxins/Furans | LWG RA Total PCDD/F (Calculated U = 1/2) | LRAtPCDDF_N |
| Dioxin TEQ | Dioxin TEQ-Avian | LWG RA Total Dioxin/Furan TEQ 1998 (Avian) (Calculated U = 1/2) | LRAtDioxFurB_N |
| Dioxin TEQ | Dioxin TEQ-Fish | LWG RA Total Dioxin/Furan TEQ 1998 (Fish) (Calculated U = 1/2) | LRAtDioxFurF_N |
| Dioxin TEQ | Dioxin TEQ-Mammalian | LWG RA Total Dioxin/Furan TEQ 2005 (Mammal) (Calculated U = 1/2) | LRAtDioxFurM_N |
| Dioxin TEQ | PCB TEQ-Avian | LWG RA Total PCB Congener TEQ 1998 (Avian) (Calculated U = 1/2) | LRAtPCBCngB98_N |
| Dioxin TEQ | PCB TEQ-Fish | LWG RA Total PCB Congener TEQ 1998 (Fish) (Calculated U = 1/2) | LRAtPCBCngF98_N |
| Dioxin TEQ | PCB TEQ-Mammalian | LWG RA Total PCB Congener TEQ 2005 (Mammal) (Calculated U = 1/2) | LRAtPCBCngCPM_N |

Notes:
BTEX = benzene, toluene, ethylbenzene, and total xylene
HPAH = high molecular weight PAH
LPAH = lower molecular weight PAH
LWG = Lower Willamette Group
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
RA = Risk Assessment
TEQ = toxic equivalent
VOC = volatile organic compound

Individual analytes included in totals are as described in Sections 4.1.1 through 4.1.9.

### ~~7.1.1~~4.1.1 PCB Totals

Total polychlorinated biphenyls (PCBs) were calculated either from the sum of individual congeners, when congener-based results were available, or as the sum of Aroclors. For samples with both Aroclor-based and congener-based results, totals were derived from congener values. There were two exceptions to this rule:

1. Task B01-01-48B_BK samples were summed based on Aroclor results, because only the dioxin-like congeners were reported
2. Task WLCOFJ02 samples had too few (15) congeners reported

Aroclor-based totals summed all reported Aroclors and assumed one half the detection limit as the result for non-detected Aroclors. The chemical name and project-specific CASRN distinguish whether the total was based on congeners or Aroclors. In the draft FS sediment database, only one PCB total (either Aroclor or congener based) exists for each sample.

PCB homolog totals were calculated consistent with risk assessment summing rules as the sum of individual PCB congeners in a homolog group. In the draft FS dataset, all reported coeluting congeners are constituents of the same homolog and did not affect multiple homolog groups. For completeness, decachlorobiphenyl, a single congener (209), is reported as both its individual analyte result and as a homolog total.

### ~~7.1.2~~4.1.2 Total PCDD/Fs

Total polychlorinated dibenzo-p-dioxin/furan (PCDD/Fs) were calculated as the sum of individual PCDD/F compounds, which is consistent with BERA summing rules. The BHHRA relies solely on tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) toxic equivalent.

### ~~7.1.3~~4.1.3 PCB and Dioxin TEQs

Toxic equivalency factors (TEFs) were used to calculate PCB and dioxin TEQs. Concentrations of relevant congeners are multiplied by their TEFs to estimate toxicity of the congeners relative to 2,3,7,8-TCDD. Resulting concentrations are summed. TEFs are published by the World Health Organization (WHO) for fish and birds (Van den Berg et al. 1998) and for mammals (Van den Berg et al. 2006).

### ~~7.1.4~~4.1.4 DDx Totals

Total DDx was calculated as the sum of the six DDx compounds: 2,4′-dichloro-diphenyl-dichloroethane (DDD); 4,4′-DDD; 2,4′-dichloro-diphenyl-dichloroethene (DDE); 4,4′-DDE; 2,4′-dichloro-diphenyl-trichloroethane (DDT); and 4,4′-DDT.

Total DDD was calculated as the sum of 2,4′-DDD and 4,4′-DDD results.

Total DDE was calculated as the sum of 2,4′-DDE and 4,4′-DDE results.

Total DDT was calculated as the sum of 2,4′-DDT and 4,4′-DDT results.

### ~~7.1.5~~4.1.5 PAH Totals

Total LPAH is the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.

Total HPAH is the sum of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

Total PAH is the sum of the individual LPAHs and HPAHs.

Total carcinogenic PAH (cPAH) is the sum of benzo(a)pyrene (BaP) equivalent (BaPEq) concentrations, calculated by multiplying the cPAHs by their respective potency equivalent factors (PEFs). cPAHs are benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, and dibenzo(a,h)anthracene. PEFs were assigned according to EPA (1993).

### ~~7.1.6~~4.1.6 Total Chlordane

Total chlordane is the sum of cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor.

### ~~7.1.7~~4.1.7 Total Endosulfan

Total endosulfan is the sum of alpha-endosulfan, beta-endosulfan, and endosulfan sulfate.

### ~~7.1.8~~4.1.8 Total Xylene

Total xylene is the sum of m,p-xylene and o-xylene.

### ~~7.1.9~~4.1.9 BTEX

BTEX is the sum of benzene, toluene, ethylbenzene, and total xylene.

## ~~7.2~~4.2 REPORTABLE ANALYTE REQUIREMENTS FOR TOTALS

The expected number of analytes for certain totals is shown in Table 2. If the number of analytes reported is limited, the total was given an “A” qualifier. Some totals had a minimum number of reportable analytes, below which totals were not calculated.

**Table 2. Result Requirements for Generating Analyte Totals**

| Chemical Name | Expected Analytes | 'A' qualify (Limited) | Do Not Sum |
|---|---|---|---|
| Total PCBs Aroclors | 7 or 9 | <7 | <2 |
| Total PCDD/Fs | 17 | <17 | <10 |
| Total HPAHs | 10 | <10 | <5 |
| Total LPAHs | 7 | <7 | <3 |
| Total PAHs | 17 | <17 | <10 |
| Total PCB Congeners | 209 | <150 | <100 |
| Sum DDD | 2 | <2 | |
| Sum DDE | 2 | <2 | |
| Sum DDT | 2 | <2 | |
| Total DDx | 6 | <6 | |
| Total Chlordane | 5 | <5 | |
| Total Endosulfan | 3 | <3 | |
| Total Xylenes | 2 | <2 | |

## ~~8.0~~5.0 DEFINITION AND PROPAGATION OF QUALIFIERS

As in the SCRA database (Appendix A3 of Integral et al. 2011), the following qualifier definitions were used in this database:

**Table 3. Analytical Chemistry Qualifier Definitions**

| Qualifier | Description |
|---|---|
| A | Summed value based on limited number of analytes. |
| J | Estimated value. |
| JA | Combined qualifier. |
| JT | Combined qualifier. |
| N | Presumptive evidence of a compound. |
| NJ | Combined qualifier. |
| NJT | Combined qualifier. |
| NT | Combined qualifier. |
| R | Rejected. |
| T | Result calculated or selected from >1 reported value. |
| U | Analyte was analyzed for but not detected. |
| UA | Combined qualifier. |
| UJ | Not detected. Sample detection limit is estimated. |
| UJA | Combined qualifier. |
| UJT | Combined qualifier. |
| UT | Combined qualifier. |

Additionally, as further discussed in Section 2 of the draft final RI (Integral et al. 2011). the N-qualifier denotes that the identity of the analyte is presumptive and not definitive, generally as a result of the presence in the sample of an analytical interference, such as hydrocarbons or, in the case of pesticides, PCBs.

In cases where average concentrations are derived from results of replicates and splits, or where analyte group totals were calculated, validation qualifiers were propagated as follows:

- J or N qualifiers were used for any individual analyte used to calculate an analyte group total were retained for the qualifying the analyte group total.
- If one or more of the results were qualified as undetected and one or more of the other results included in a calculated analyte group total were detected and qualified as estimated, the calculated value was qualified as estimated.
- If all of the included results were detected and one or more of the results were qualified as estimated, the calculated value was qualified as estimated.
- The “Detect” field was populated with a Y for detected values and an N for non-detects for all sample results and calculated values.

- Rejected values were not used in averages or totals.
- A T qualifier was added to all results that were calculated (e.g., totals and averages of multiple results) and all results that are selected for reporting in preference to other available results (e.g., for parameters reported by multiple methods).

## ~~9.0~~6.0 SIGNIFICANT FIGURES

The reporting to significant figures was handled as in Integral et al. (2011). Analytical results provided by laboratories were maintained in the database as text values, in the format received from the reporting laboratories, so that the number of significant figures provided by the labs would not be lost by either the addition or removal of trailing zeros. For example, if the lab file contained 1.0, then that text string would be maintained to avoid conversion to either 1.00 or 1. In some cases, the lab-reported value appeared to have only one significant figure (1, for example). But a minimum of two significant figures was assumed for all results, which was consistent with the standard reporting requirements of analytical laboratories.

During calculations, such as averaging replicates or summing for totals, all significant figures were carried through the calculation. The final result was then rounded to the smallest number of significant figures found in the values used in the calculation. For example: 7010 + 105 + 20.8 = 7135.8, and with three significant figures equals 7140.

## ~~10.0~~7.0 CHANGE LOG

The draft FS database was originally distributed on May 27, 2010.

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This database has been updated, per June 16, 2010, version, to correct a discrepancy in the totaling of benzo-fluoranthenes (PAH group).

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Additional SCRA data was added from September 9, 2009, to February 4, 2011.

Change log updates through February 3, 2011 13:11 were included.

The 2014 FS database includes surface and subsurface sediment data collected at the Gasco/~~ and~~ Siltronic and Arkema early action sites through April 2011.

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## ~~11.0~~8.0 REFERENCES

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**Commented [A1]:** Update based on new RI reference, when available